



UNIVERSITÉ DE GENÈVE

AMS Tracker Thermal Control Subsystem

# TTCS Accumulator Rework requirements

AMSTR-NLR-TN-054

ISSUE 1.2

OCTOBER 2008

Sun Yat-Sen University (SYSU)  
National Aerospace Laboratory (NLR)  
Istituto Nazionale di Fisica Nucleare (INFN)

	NAME	ORGANISATION/RESPONSIBILITY	SIGNATURE	DATE
PREPARED	J. van Es	NLR		21/10/2008
CHECKED	J. van Es	NLR / AMS SE		21/10/2008
AGREED	A. Pauw	NLR / AMS PA		
APPROVED	J. van Es	NLR / AMS PM		21/10/2008
AUTHORISED	P. Dieleman	NLR Space Department		21/10/2008

FILENAME	AMSTR-NLR-TN-054-Accumulator-rework-reqs_1_2.doc	ORDER-/CODENUMBER:	2494047
LAST SAVED	2008.10.21 11:37 by jvanes	DIVISION:	AS&A
PRINTED	2008.10.21 11:39	DISTRIBUTION:	Unlimited
PAGES	26	CLASSIFICATION TITLE:	Unclassified

No part of this document may be reproduced and/or disclosed, in any form or by any means, without the prior written permission of NLR.



UNIVERSITÉ DE GENÈVE

---

**AMS Tracker Thermal Control Subsystem**

**TTCS Accumulator Rework  
requirements**

**AMSTR-NLR-TN-054**

**ISSUE 1.2**

**OCTOBER 2008**

---

Sun Yat-Sen University (SYSU)  
National Aerospace Laboratory (NLR)  
Istituto Nazionale di Fisica Nucleare (INFN)

	NAME	ORGANISATION/RESPONSIBILITY	SIGNATURE	DATE
PREPARED	J. van Es	NLR		
CHECKED	J. van Es	NLR / AMS SE		
AGREED	A. Pauw	NLR / AMS PA		
APPROVED	J. van Es	NLR / AMS PM		
AUTHORISED	P. Dieleman	NLR Space Department		

FILENAME	AMSTR-NLR-TN-054-Accumulator-rework-reqs_1_2.doc	ORDER-/CODENUMBER:	2494047
LAST SAVED	2008.10.21 11:37 by jvanes	DIVISION:	AS&A
PRINTED	2008.10.21 11:39	DISTRIBUTION:	Unlimited
PAGES	26	CLASSIFICATION TITLE:	Unclassified

*No part of this document may be reproduced and/or disclosed, in any form or by any means,  
without the prior written permission of NLR.*



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page 2 of 26  
Doc.Id AMSTR-NLR-TN-054  
Issue 1.2  
Date October 2008

## Distribution list

Company	FOR*	Name	Comments
SYSU	I	Z.H. He	
		X. Qi	
		T. Li	
INFN	I	R. Battiston	
		M. Menichelli	
		C. Gargiulo	
		A. Alvino	
		E. Laudi	
AMS	I	M. Capell	
		V. Koutsenko	
		R. Becker	
NLR	I	P. Dieleman	
		J.van Es	
		M. Bardet	
Jacobs Sverdrup	I	T. Martin	
		G. Clark	
CGS	I	M. Molina	
		C. Vettore	

A = Approval  
R = Review  
I = Input / Information

An electronic version of this document is available on the AMS TTCS website:  
<https://ams-ttcs.nlr.nl>



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page 3 of 26  
Doc.Id AMSTR-NLR-TN-054  
Issue 1.2  
Date October 2008

## Document change log

<u>Change Ref.</u>	<u>Section(s)</u>	<u>Issue 1.0</u>
-	All	Initial issue
<u>Change Ref.</u>	<u>Section(s)</u>	<u>Issue 1.1</u>
	Section 5	Cleanliness check clarified (lint-free cloth explained)
	Appendix A	Update drawing
<u>Change Ref.</u>	<u>Section(s)</u>	<u>Issue 1.2</u>
	Section 5	Possible HP tube extension alternatives clearly mentioned.
	Section 6	Update accumulator drawing Figure 6-1 with brackets as reference.
	Section 7	Added tolerances on bending angles, radii and lengths. Added similar drawing with angle indication for Primary Peltier tube



UNIVERSITÉ DE GENÈVE



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page	4 of 26
Doc.Id	AMSTR-NLR-TN-054
Issue	1.2
Date	October 2008

## Summary

This document describes the requirements for TTCS accumulator re-work. The document is applicable for the QM, FM1 and FM TTCS accumulators re-work. The document describes the scope of the work.

It addresses the following topics:

1. Heat pipe emptying, welding, vacuumizing, sealing
2. Liquid inlet tube cutting requirements
3. Peltier pipe re-bend to the final 90°
4. Fit check on the interface with the TTCB base-plate
5. Heat pipe filling and sealing



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page	5 of 26
Doc.Id	AMSTR-NLR-TN-054
Issue	1.2
Date	October 2008

## Contents

<b>Document change log</b>	<b>3</b>
<b>Summary</b>	<b>4</b>
<b>1 Scope of the document</b>	<b>6</b>
<b>2 References documents</b>	<b>6</b>
<b>3 Introduction</b>	<b>7</b>
3.1 Description of Flight Hardware involved	8
3.2 Replacement of the wire heaters	9
3.3 Replace all QM and FM wire heaters by 1 mm wire heaters with more robust connectors	10
<b>4 Re-work summary in steps</b>	<b>11</b>
<b>5 Heat Pipe emptying, extension and sealing</b>	<b>12</b>
<b>6 Liquid inlet tube cutting</b>	<b>13</b>
<b>7 Peltier Pipe check and re-bending</b>	<b>17</b>
<b>8 Fit check on the interface with the TTCB base-plate</b>	<b>19</b>
<b>9 Heat pipe filling and sealing</b>	<b>19</b>
<b>END OF DOCUMENT</b>	<b>26</b>

(26 pages in total)



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page 6 of 26  
Doc.Id AMSTR-NLR-TN-054  
Issue 1.2  
Date October 2008

## 1 Scope of the document

The activities concern the activities needed to replace the 4 x 0.5 mm diameter wire heaters by 2 x 1.0 mm wire heaters. The rework action sequence is as follows and indicates the responsible company:

1. Heat pipe emptying, extension welding, vacuumizing, sealing (CAST)
2. Liquid inlet tube cutting (CAST)
3. Peltier pipe re-bend to the final 90° (CAST)
4. Fit check on the interface with the TTCB base-plate (CAST/SYSU)
5. Desoldering, cleaning and re-soldering of the wire heaters around the accumulator heat pipe (NLR performed at SYSU)
6. Heat pipe filling and sealing (CAST)
7. Integration in TTCB's (AIDC)

This document describes the steps performed at CAST and focuses on the requirements.

## 2 References documents

	Title	Number
RD-1	NLR-Memorandum TTCS Accumulator Specification	AMSTR-NLR-TN-18-Issue03
RD-2	Appendix A: Accumulator Safety Input Definition	APPENDIX TO AMSTR-NLR-TN-018
RD-3	Safety Analysis of the Heat Pipe 14.03.2007	AMS02-CAST-TTCS-HP-SF-001
RD-4	Design of TTCS Accumulator	AMS02-CAST-TTCS-ACC-DR-001

### 3 Introduction

The repair concerns the TTCS QM accumulator wire heater around the QM accumulator heat pipe. One of the 0.5 mm wire heaters located around the heat pipe is broken as can be seen in the picture with the light blue circle around it.



**Figure 3-1: Picture of the broken QM accumulator wire heater**

The accumulator wire heaters are wrapped and soldered around the heat pipe.

It concerns the following wire heaters:

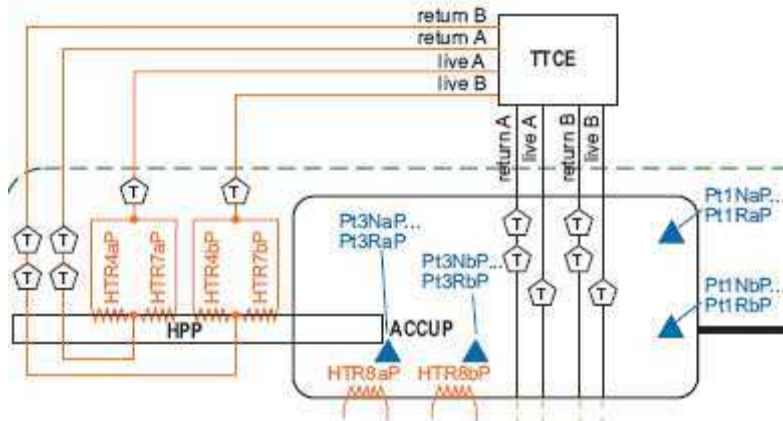
Accu Flight Control Heater	1NcAc05/697mm/TI/2xCM05SPE/CEMENT8/E1419WHITE/200mm	2x (1A, 1B)
Accu Emergency Heater	1NcAc05/1044mm/TI/2xCM05SPE/CEMENT8/ E1419WHITE/200mm	2x (1A, 1B)

**Table 3-1: Wire heaters attached to the accumulator heat pipe**

Both wire heaters are 0.5 mm ThermoCoax wire heater with CEMENT08 connectors to the electrical wires AWG 14. The CEMENT08 connectors on the 0.5 mm heater wires are found to be brittle during integration of the accumulator and also the pre-heater manufacturing.



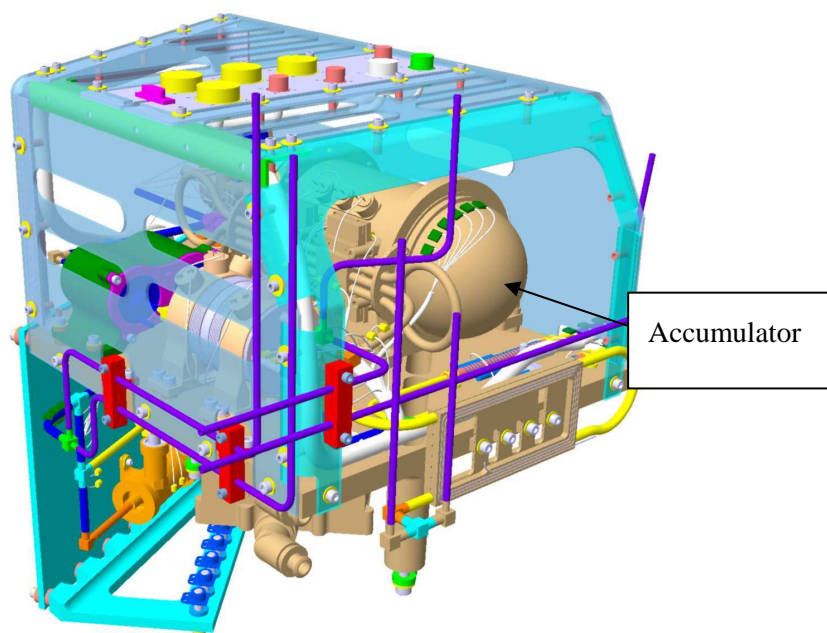
The accumulator control heaters are electronically connected in parallel as shown in Figure 3-2 and are controlled with one PWM-controller.



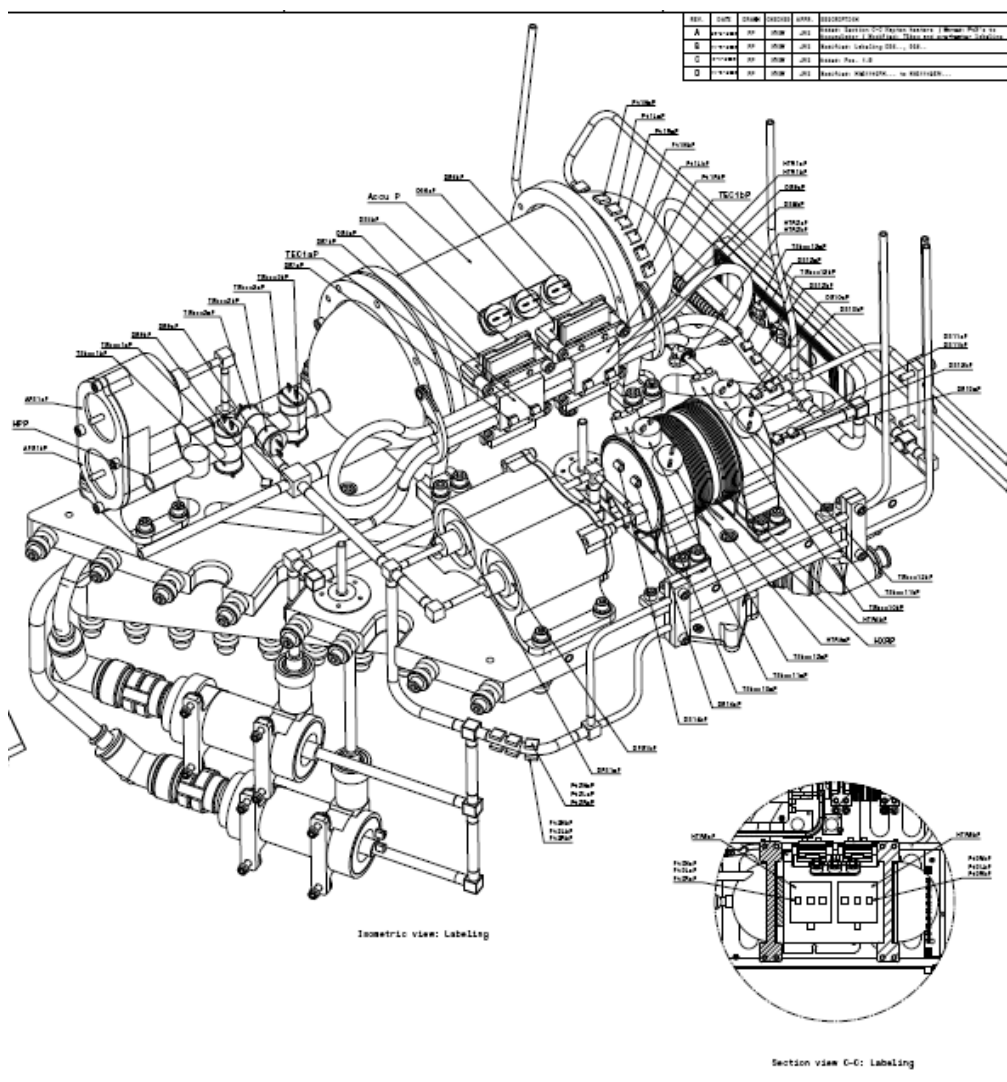
**Figure 3-2: Accumulator emergency (HTR4) and control heater (HTR7) schematic**

## 3.1 Description of Flight Hardware involved

The TTCS accumulator control and emergency heaters are located inside the TTCSB box.



**Figure 3-3: TTCS Box with TTCS accumulator**



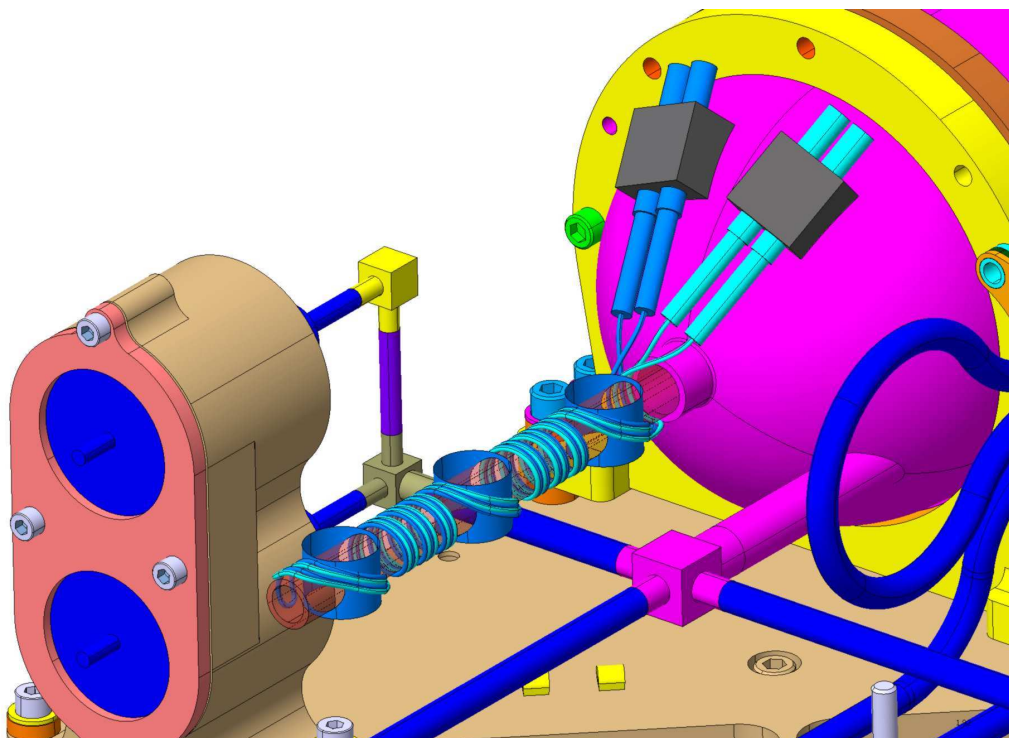
**Figure 3-4: Assembly drawing TTCS Box with TTCS accumulator**

### 3.2 Replacement of the wire heaters

In order to repair the QM accumulator there were 2 options:

1. Replace QM accumulator wire heaters by new ones
2. Replace all QM and FM wire heaters by 1 mm wire heaters with more robust connectors

It is decided to replace all QM and FM wire heaters by 1 mm wire heaters as this is better for robustness during launch vibrations.



**Figure 3-5: Wire heater lay-out with 1.0 mm wire heaters**

The wire specification is as follows:

Accu Flight Heater	1HcAc10/746mm/2xCM10/CEMENT8/E1419WHITE(AWG14)/200mm
--------------------	--

### 3.3 Replace all QM and FM wire heaters by 1 mm wire heaters with more robust connectors

This method foresees in the replacement of the four 0.5 mm diameter wire heaters by two 1 mm diameter wire heaters.

The advantage of this option is that the brittle connectors of the 0.5 mm wire heaters can be replaced by the more robust 1.0 mm wire heater connectors.

Consequence of this replacement is that also the wire heaters of the 2 FM accumulators need to be replaced.



UNIVERSITÉ DE GENÈVE



## AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page	11 of 26
Doc.Id	AMSTR-NLR-TN-054
Issue	1.2
Date	October 2008

### 4 Re-work summary in steps

In summary the rework steps are:

1. Heat pipe emptying, extension welding, vacuumizing, sealing (CAST)
2. Desoldering, cleaning and soldering of the 1.0 mm wire heaters around the accumulator heat pipe (NLR performed at SYSU)
3. Heat pipe filling and sealing (CAST)

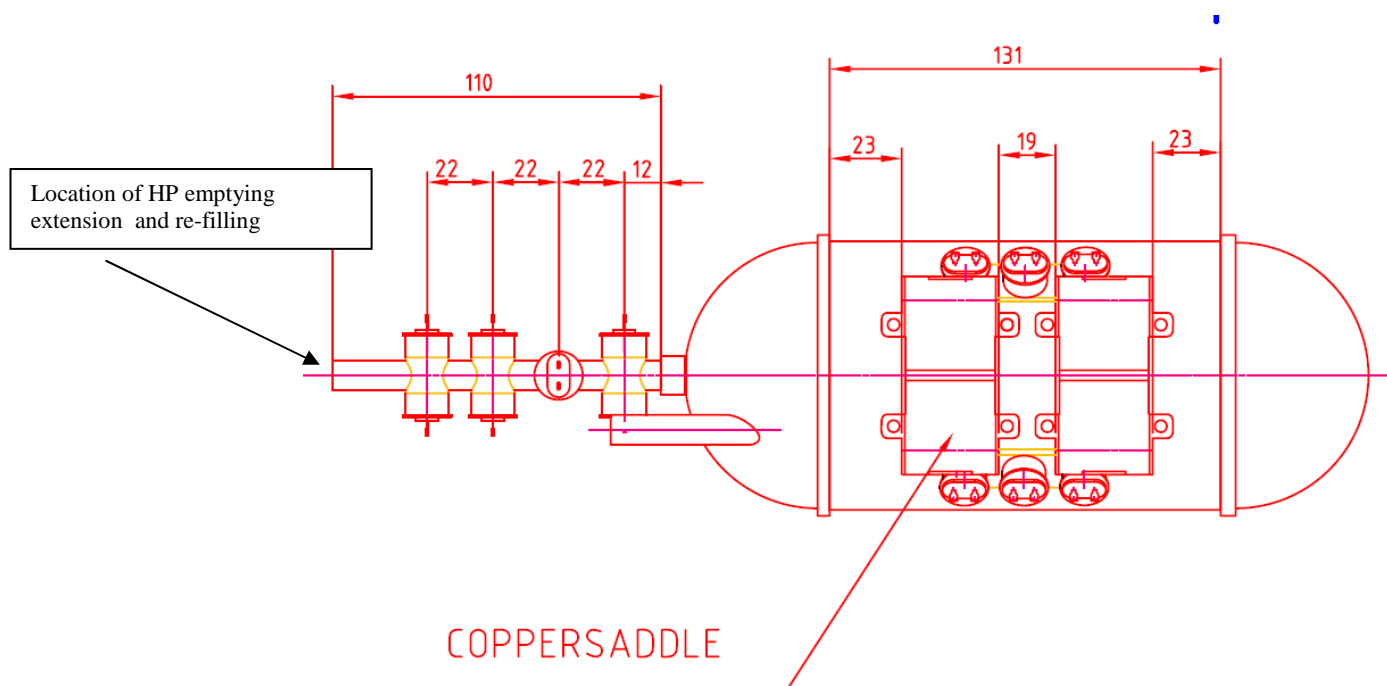
Additional to the solder re-work the following additional re-work is requested

1. Liquid inlet tube cutting (CAST)
2. Peltier pipe re-bend to the final 90° (CAST)
3. Fit check on the interface with the TTCB base-plate (CAST/SYSU)

The requirements applicable for the steps are presented in the next sections.

## 5 Heat Pipe emptying, extension and sealing

As the accumulator Heat Pipe (HP) contains  $\text{NH}_3$  it is needed to empty the heat pipe, extend it so it can be re-filled and vacuumize and seal the HP to avoid oxidation on the inside of the heat pipe during the de-soldering, cleaning and soldering of the heat pipe wire heaters.



**Figure 5-1: Accumulator drawing**

The requirements mentioned in RD-01 as far valid for the heat pipe should be met.

The following requirements are special applicable for the HP emptying, extension and sealing.

1. Material traceability of added stainless steel material (section 5.9.7 in RD-1)
2. Internal CAST welding requirements
3. Internal CAST vacuumizing and sealing requirements

The extension of the HP can be done with a tube of  $D_{\text{outer}} = 4 \text{ mm}$ ,  $t = 1 \text{ mm}$  used in the original design. Also an extension tube with  $D_{\text{outer}} = 3 \text{ mm}$ ,  $t = 0.5 \text{ mm}$  can be used for the repairs as alternative.

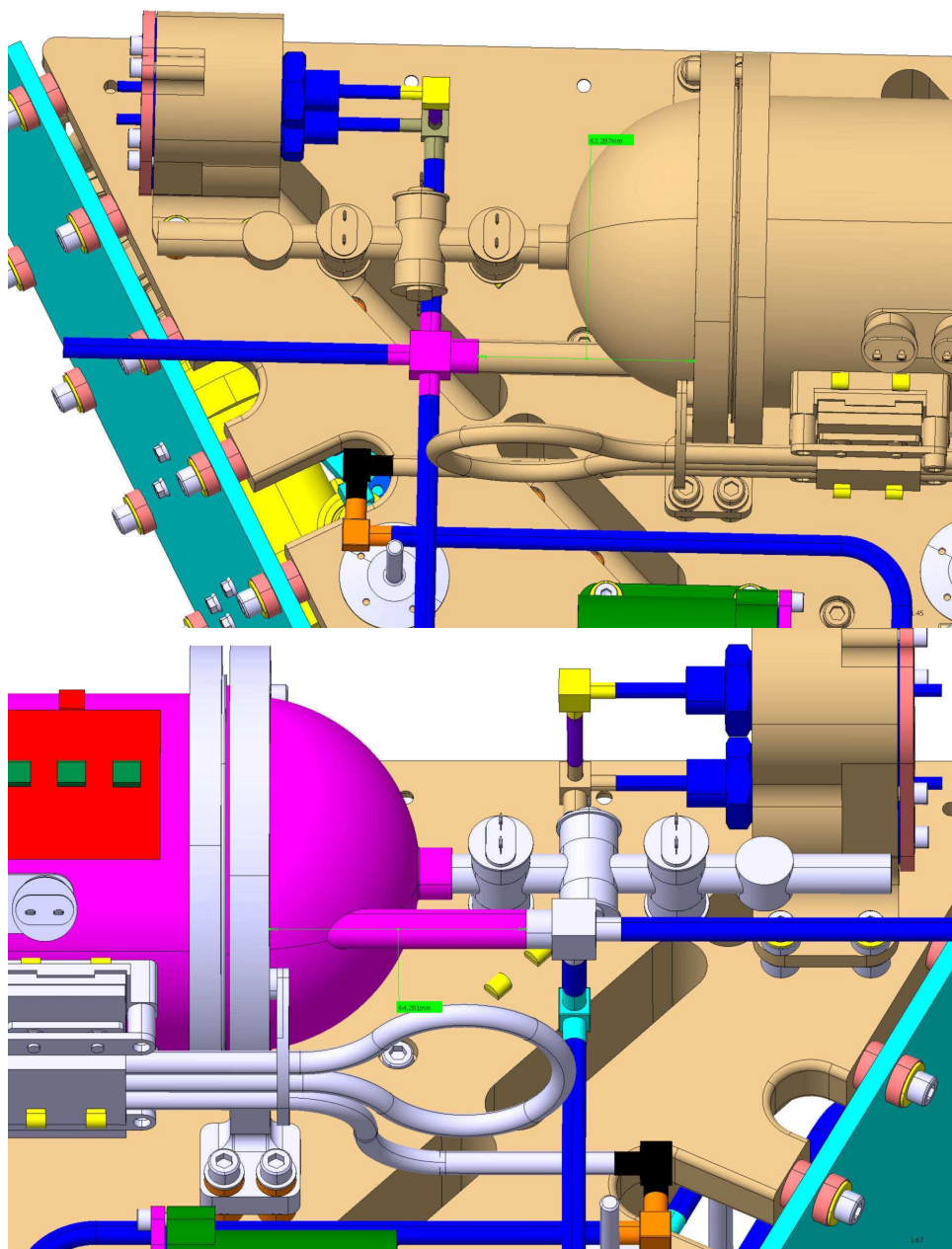


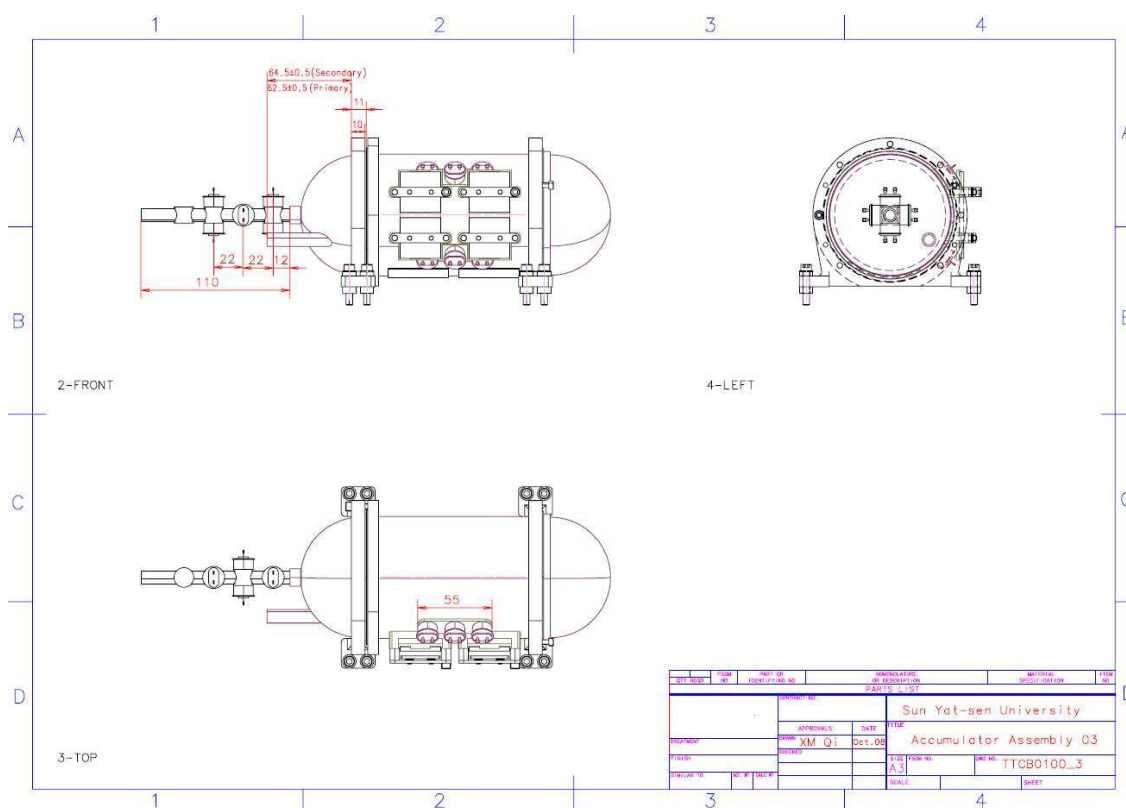
## 6 Liquid inlet tube cutting

In order to be able to weld the accumulator to the TTCB tubing the liquid inlet tube cutting needs to be performed. It is requested to CAST to perform this delicate task.

The mechanical requirements are as follows:

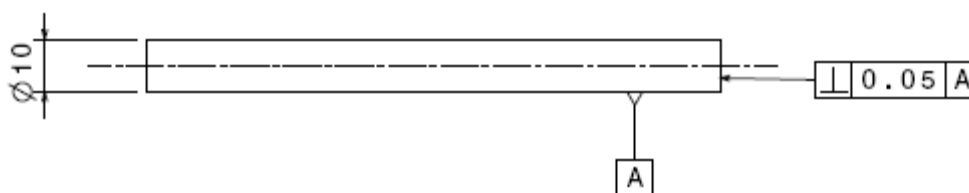
- ACC034-01 Liquid inlet pipe length requirement





**Figure 6-1: Length requirement for the inlet pipe cutting**

- ACC035-01 Liquid inlet pipe squareness requirement



**Figure 6-2: Squareness requirement for the feed-pipe cutting**

In Figure 6-1 it is shown that there is a difference in length between the Primary box and the Secondary box liquid inlet tube. For completeness the length for QM, FM1 and FM2 are presented in Table 6-1 below.

Accumulator model	Liquid inlet tube length requirement
FM1 Primary box	62.5 ± 0.5 mm
FM2 Secondary box	64.5 ± 0.5 mm (attention longer)
QM Primary box	62.5 ± 0.5 mm

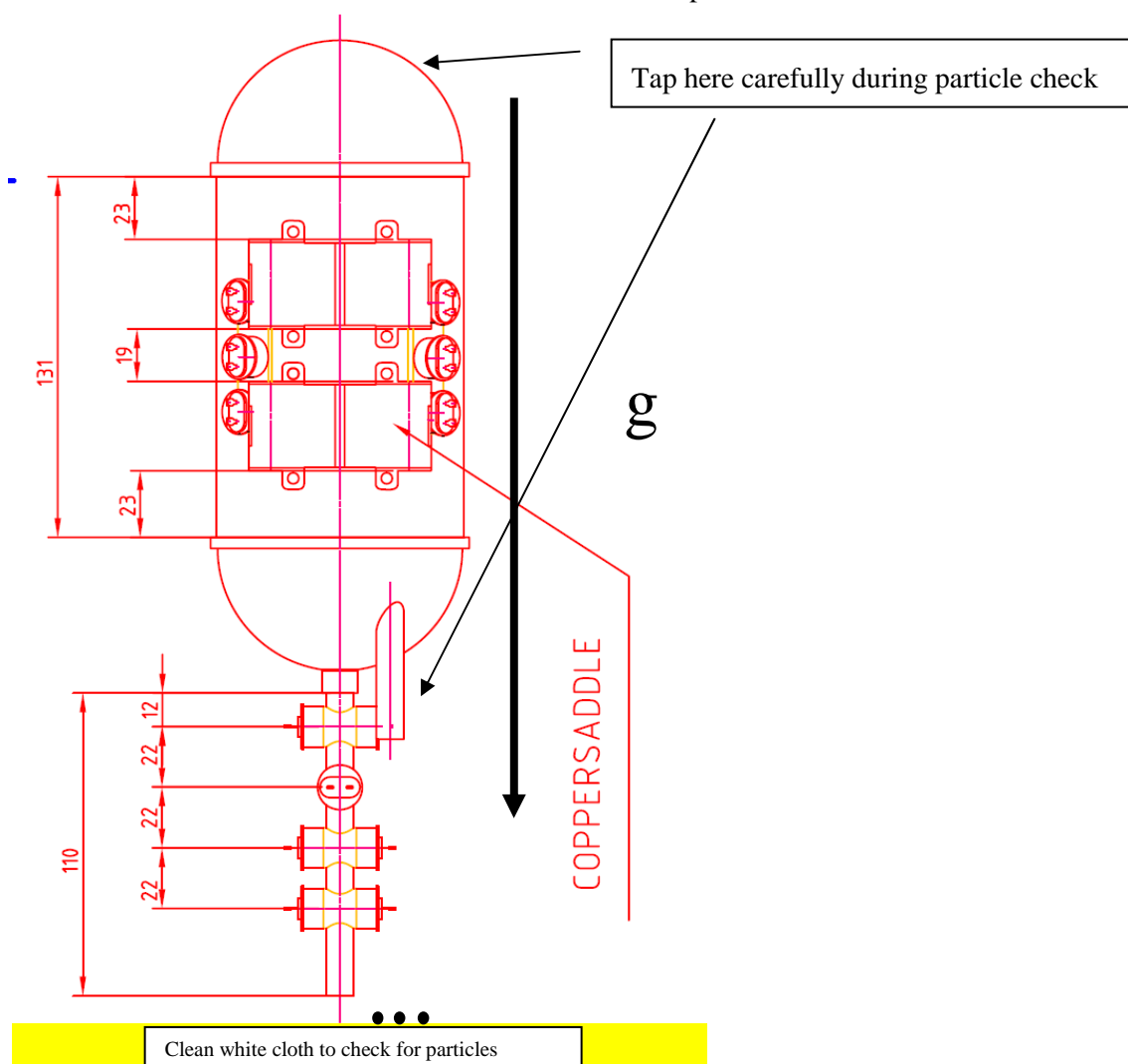
**Table 6-1: Summary of liquid inlet tube length for FM and QM accumulator models**

## Cleanliness:

The requirement ACC18-01 is not valid for the inlet pipe cutting. This requirement is replaced by a clean working procedure requirement to avoid contamination and a cleanliness visual check.

- ACC036-01: The liquid inlet pipe cutting should be done by dry cutting and milling (no fluids to be used)
- ACC037-01: The liquid inlet pipe cutting should be performed such that gravity is downward

A possible (optional) additional measure is to put a temporary stop (from lint-free cloth or rubber) in the inlet tube which can be removed after milling. Upto the manufacturer to decide if and how this can be done. This would decrease the risk of particle contamination.



**Figure 6-3: Accumulator orientation during cutting (and set-up particle check)**





UNIVERSITÉ DE GENÈVE



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page	16 of 26
Doc.Id	AMSTR-NLR-TN-054
Issue	1.2
Date	October 2008

After milling and cutting remove sharp edges and clean the tube entrance with lint-free cloth with Iso Propyl Alcohol.

Remark: Lint free cloth is cloth not leaving parts of the cloth fabric behind.

ACC 10-01: Perform a He-leak test after cutting to proof mechanical integrity of the accumulator (please reply if possible)

ACC039-01: After cutting, milling, He-leak test and cleaning a particle check shall be performed by keeping the accumulator upside down and tap with a finger or small instrument on the top of the accumulator

If no particles are found on the close the inlet tube with the end cap.

If particles are found repeat the entrance tube cleaning with lint-free cloth and repeat the particle check ACC-039-01. If repeatedly still particles are found contact TTCS project manager for further action.

Remark: It is decided NOT to flush with gas and or fluids.



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page

Doc.Id

Issue

Date

17 of 26

AMSTR-NLR-TN-054

1.2

October 2008

## 7 Peltier Pipe check and re-bending

During the accumulator inspection it was found that the Peltier pipe was not fully bend according to the drawings.

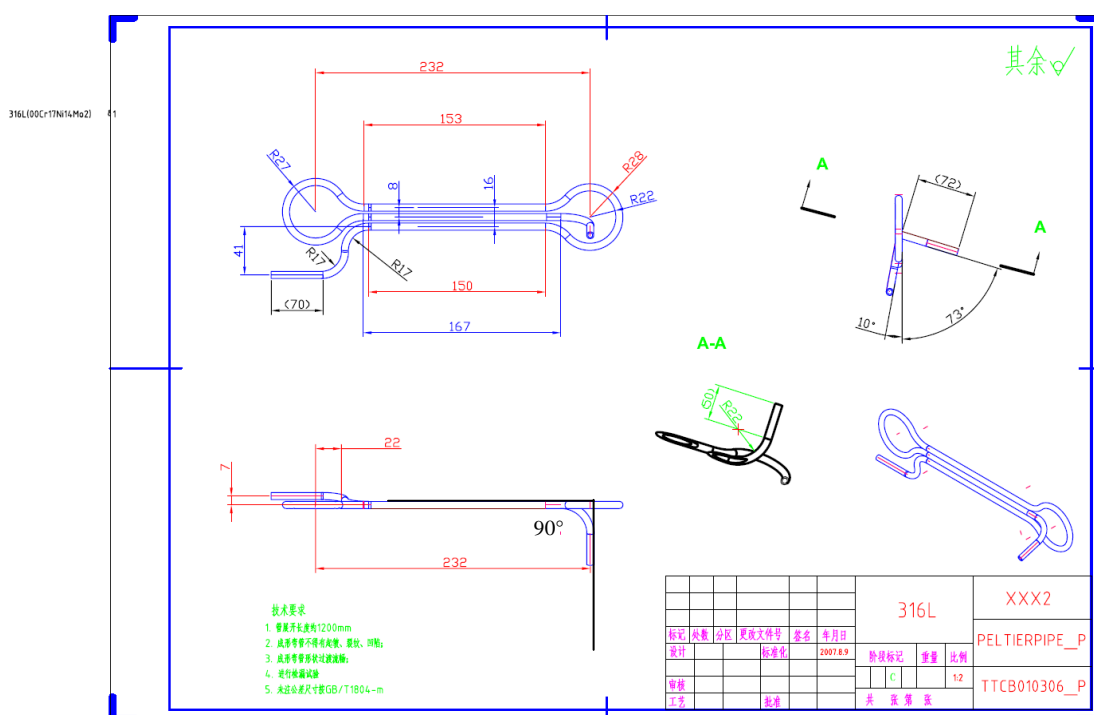


Figure 7-1: Indication of bending misalignment Primary Peltier tubing



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page

18 of 26

Doc.Id

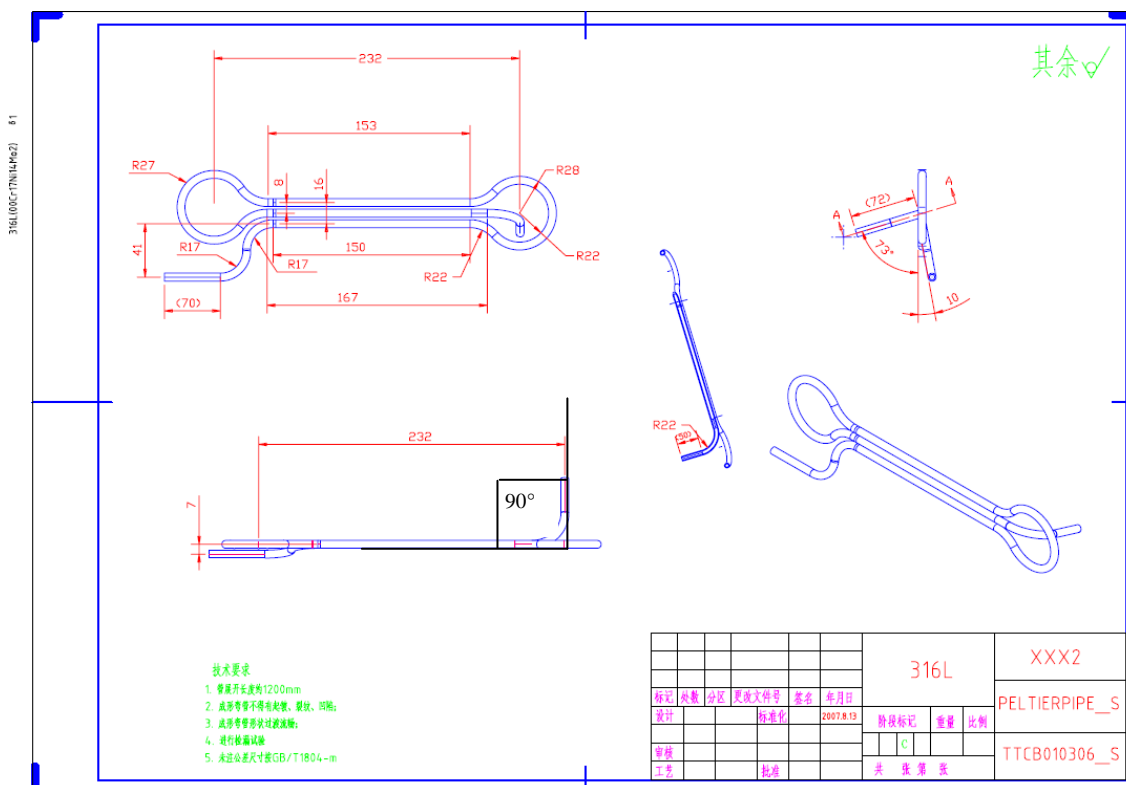
AMSTR-NLR-TN-054

Issue

1.2

Date

October 2008



**Figure 7-2: Indication of bending misalignment Secondary Peltier tubing**

In Figure 7-1 and Figure 7-2 in black the angle between the axis of the bend should be 90°. This is however not the measured value. It is upto the supplier to decide how to perform the bending to 90°.

The tolerances on bending in the TTCS boxes (including Peltier piping) are:

Length:  $\pm 0.5$  mm

Radii:  $\pm 1$

Angle:

NOMINAL LENGTH OF SHORT ANGLE SIDE		ANGLE DEVIATION	
LARGER THAN	UNTIL INCL.	DEG.	mm / 100mm
-	10	$\pm 1^\circ$	$\pm 1,8$
10	50	$\pm 0,5^\circ$	$\pm 0,9$
50	120	$\pm 0,3^\circ$	$\pm 0,5$
120	400	$\pm 0,15^\circ$	$\pm 0,3$



## **AMS Tracker Thermal Control Subsystem**

TTCS Accumulator Rework

Page	19 of 26
Doc.Id	AMSTR-NLR-TN-054
Issue	1.2
Date	October 2008

### **8 Fit check on the interface with the TTCB base-plate**

After the change of bends and the cutting of the tube a fit check on the mechanical interface to the base plate holes should be performed to assure proper aligning during TTCB box integration.

The hole patterns of the Primary and Secondary base plates are shown in Appendix C for reference.

### **9 Heat pipe filling and sealing**

For the heat pipe filling and sealing of the accumulator heat pipe the heat pipe requirements from RD-1 to RD-4 will apply.

The sequence of RD-4 should apply.

8.14 Fill HP with Ammonia

8.14.1 Verify filling mass

8.14.2 Proof pressure test HP

No additional vibration testing is required after sealing.

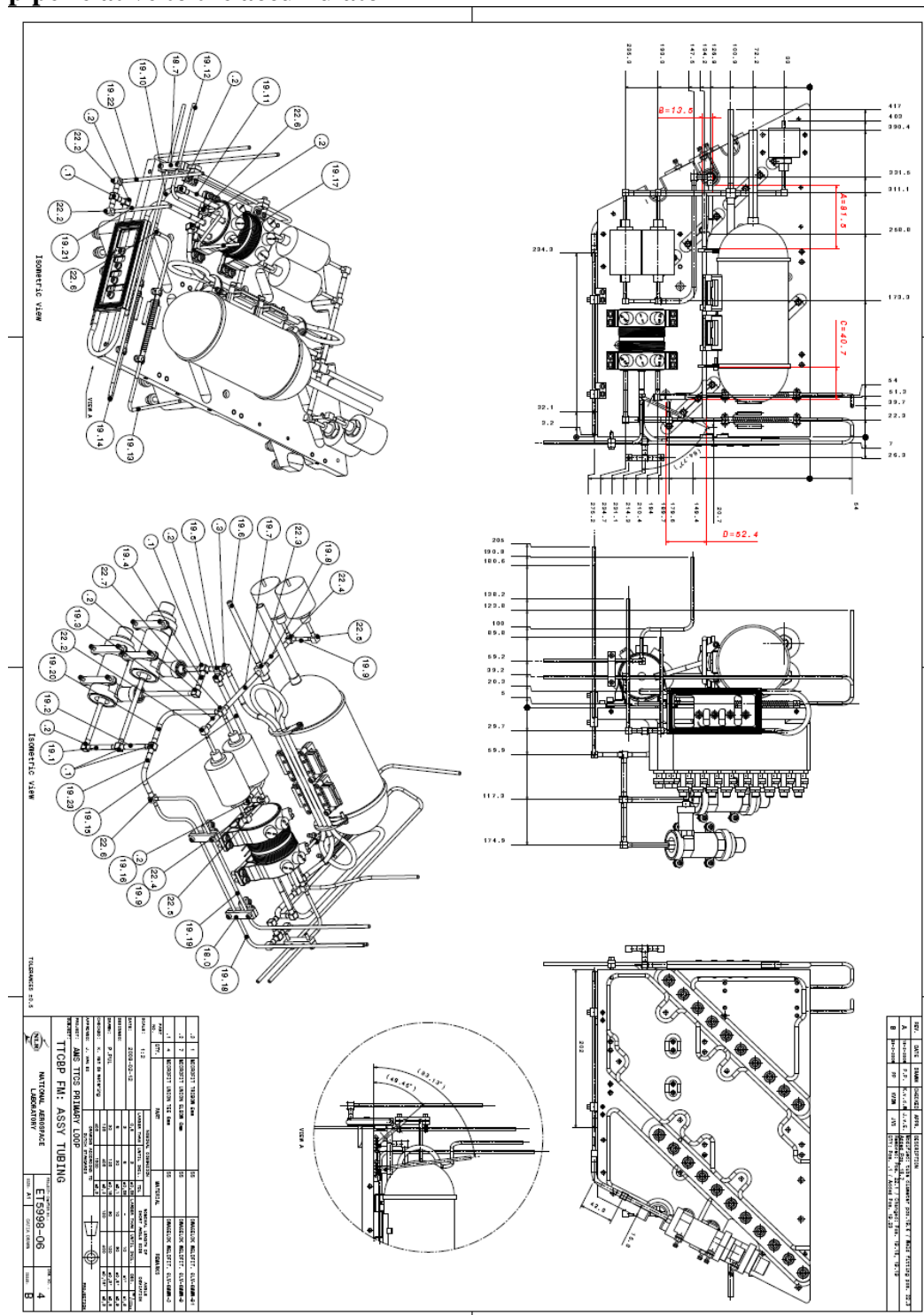


# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework requirements

Page	20 of 26
Doc.Id.	AMSTR-NLR-TN-054
Issue	1.2
Date	October 2008





# AMS Tracker Thermal Control Subsystem

## TTCS Accumulator Rework

Page

Doc.Id

## Issue

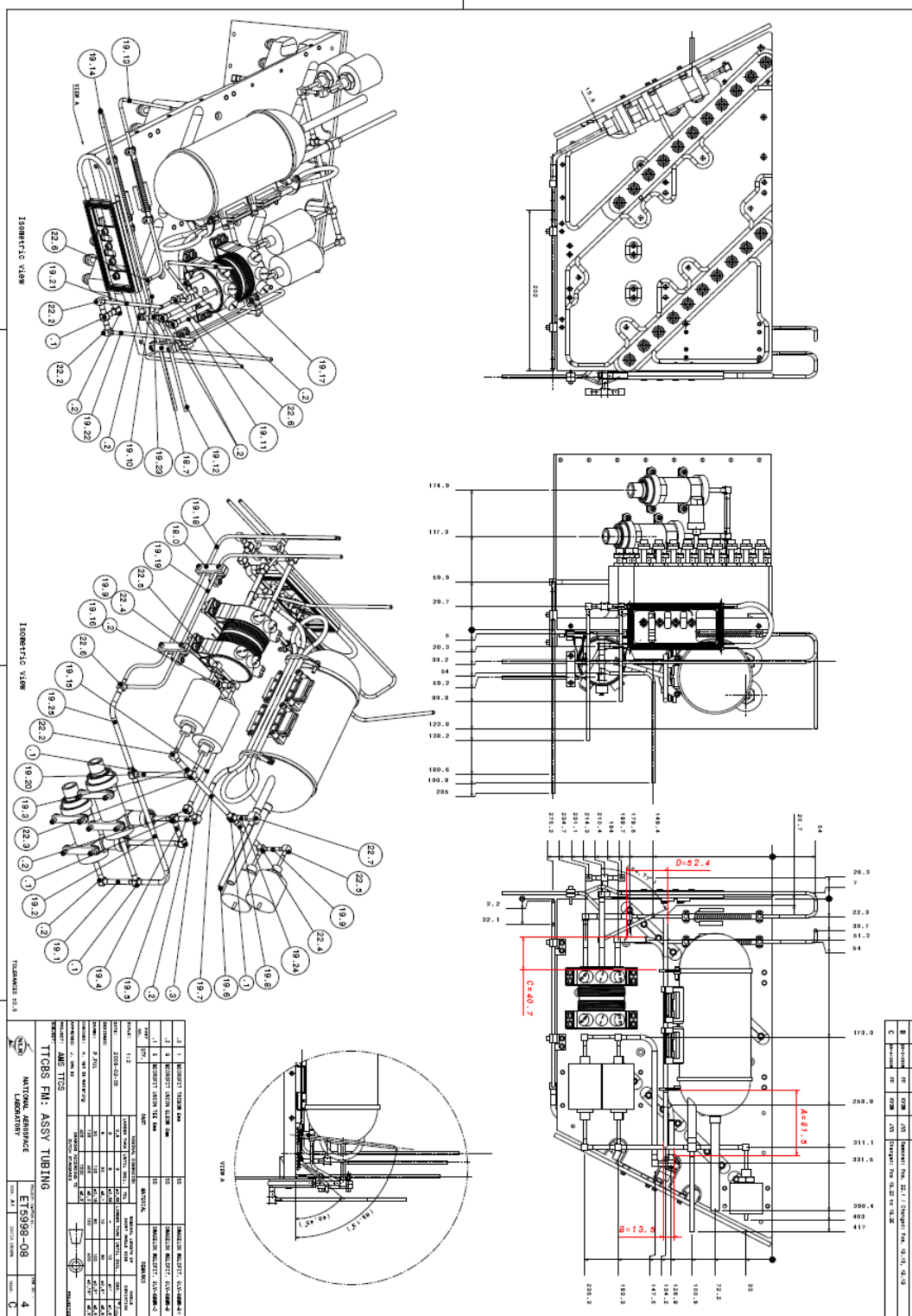
Date \_\_\_\_\_

23 of 26

**AMSTR-NLR-TN-054**

## 1.2

October 2008





Primary TTCB base plate. Accumulator is connected by holes 14, 15, 18, 19, 32, 33, 34, 35.

Secondary TTCB base plate. Accumulator is connected by holes 14, 15, 18, 19, 32, 33, 34, 35



UNIVERSITÉ DE GENÈVE



中山大學



# AMS Tracker Thermal Control Subsystem

TTCS Accumulator Rework

Page	26 of 26
Doc.Id	AMSTR-NLR-TN-054
Issue	1.2
Date	October 2008

END OF DOCUMENT